

## ***CTE Standards Unpacking*** ***Bioprocess Engineering***

**Course:** Bioprocess Engineering

**Course Description:** This course is designed to provide information on broad application of ever-emerging field of bioprocessing for students in South Dakota. Students are engaged in an instructional program that integrates academics and technical preparation and focuses on career awareness in bioprocess engineering. This course will prepare students for advanced opportunities that lie in the area of biotechnological advancement. The student will apply the knowledge of engineering and biological sciences to design and develop a process capable of ameliorating environmental pollution, producing valuable products and applying novel technologies to produce alternative sources of transportation fuel. Topics that will be covered in this course include: water and wastewater treatment plants, recycling and reuse, and fermentation processes.

**Career Cluster:** STEM

**Prerequisites:** None

**Program of Study Application:** This is a pathway course in the STEM cluster engineering pathway. It is recommended that the course be preceded by a series of foundation courses, a cluster course in STEM and more specialized pathway courses such as Introduction to Engineering, Engineering Design and Development, and Introduction to Manufacturing and followed by dual credit course and/or capstone course.

<b>INDICATOR #BE 1: Understand the basic concepts of bioprocess system and biotechnological processes</b>		
<b>SUB-INDICATOR 1.1 (Webb Level: 1 Recall):</b> Identify bio-based products		
<b>SUB-INDICATOR 1.2 (Webb Level: 1 Recall):</b> Identify microbial processes that can be implemented in bioprocessing		
<b>SUB-INDICATOR 1.3 (Webb Level: 2 Understand, Demonstrate):</b> Understand how biotechnology can be integrated with engineering		
<b>Knowledge (Factual):</b>	<b>Understand (Conceptual):</b>	<b>Skills (Application):</b>
Differentiate between processed and raw products	Producing various value added products using agricultural by-products	Be able to identify different approaches to convert agricultural wastes into value added products
Microorganisms are used to produce value added chemicals, pharmaceuticals,	Integrating engineering principles and biological sciences to produce new products	Be able to design the processes and produce

degradable products etc Fundamental principles of engineering are integrated with biological sciences		new products
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### **Benchmarks**

*Students will be assessed on their ability to:*

- List different types of the products that you think are based on biological materials and can be recycled and reused.
- List different types of microorganisms and processes that can be used to produce, food, feed and various bioplastics.
- Design processes to ensure the cost-effective methods for long term storage of the products or cost-effective transportation and handling method for the new products.

### **Academic Connections**

#### **ELA Literacy and/or Math Standard (if applicable, Science and/or Social Studies Standard):**

9-10.RI.3 Analyze how the author unfolds an analysis or series of ideas or events, including the order in which the points are made, how they are introduced and developed, and the connections that are drawn between them

11.W.6 Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information

#### **Sample Performance Task Aligned to the Academic Standard(s):**

Do industry visits

Tour of research oriented universities and colleges to learn about the biotechnology and bioprocessing research

Read three most recent peer reviewed research articles and summarize their findings in your own words.

Be sure to cite the reference.

### **INDICATOR #BE 2: Apply basic knowledge of biological science and engineering in developing products**

**SUB-INDICATOR 2.1 (Webb Level: 1 Recall):** Understand how raw materials are used for developing products

**SUB-INDICATOR 2.2 (Webb Level: 1 Recall):** Understand how the chemical composition of a raw material affects the design process

<b>Knowledge (Factual):</b>	<b>Understand (Conceptual):</b>	<b>Skills (Application):</b>
<p>Terminologies and definitions of biological materials.</p> <p>Physical and chemical composition of biological materials.</p> <p>Know that type of process and composition of the raw material play an important in developing a new product.</p> <p>Biotechnological processes.</p>	<p>Different types of raw products (biological materials) exist.</p> <p>Biological materials have different structural and chemical composition.</p> <p>Processes can be designed according to the composition of the raw material and end desired end product.</p>	<p>Be able to apply biotechnological processes in utilizing waste product to make valuable product.</p>

### **Benchmarks**

*Students will be assessed on their ability to:*

- List various types of the snacks food and raw materials that are used to produce them.
- List different techniques that likely were used to produce the new product.
- Differentiate between biochemical components of different food products for example banana and corn. Can banana be stored the same way as corn? Yes or no, if no why?
- Analyze what kind of storage design would banana require as compared to corn

### **Academic Connections**

<b>ELA Literacy and/or Math Standard (if applicable, Science and/or Social Studies Standard)</b>	<b>Sample Performance Task Aligned to the Academic Standard(s):</b>
<p>9-10.RI.3 Analyze how the author unfolds an analysis or series of ideas or events, including the order in which the points are made, how they are</p>	<p>Do industry visits</p> <p>Perform mini-laboratory activities for product development</p> <p>Read three most recent peer reviewed research articles and summarize the key</p>

<p>introduced and developed, and the connections that are drawn between them</p> <p>11.W.6 Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information</p>	<p>outcomes in your own words. Be sure to cite the reference</p>
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<b>INDICATOR #BE 3: Understand issues associated with implementation and operation of biotechnological processes</b>		
<b>SUB-INDICATOR 3.1 (Webb Level: 3):</b> Analyze problems associated with bioprocessing; for example, environmental, technical, sustainable		
<b>SUB-INDICATOR 3.2 (Webb Level: 2):</b> Understand how to operate a bioreactor		
<p><b>Knowledge (Factual):</b></p> <p>Challenges of the biological/biotechnological processes</p> <p>Environmental, societal and cultural impact of bioprocessing</p> <p>Bioreactors operating skills</p> <p>Knowing the range of biotechnological processes</p>	<p><b>Understand (Conceptual):</b></p> <p>Biotechnological processes can have different challenges</p> <p>Biotechnological inventions can have cultural, societal and environmental impact</p> <p>Biotechnological processes are very specific to the product and starting material (Raw material) hence specific operating skills need to be developed</p>	<p><b>Skills (Application):</b></p> <p>Be able to understand the ethical, environmental, financial challenges associated with bioprocessing</p> <p>Be able to understand the what kind of skill-set would be needed to operate the bioreactor</p>

## **Benchmarks**

*Students will be assessed on their ability to:*

- Discuss ethical issues associated with bioprocessing
- Analyze economic and environmental impacts of bioprocessing
- Differentiate between sustainable and non-sustainable bioprocessing techniques
- Identify different procedures used in biotechnological processes
- Label the components of bioreactor
- List different types of products that can be produced from agricultural products
- Understand what kind of reactors or operating machine you may need for producing these products
- Understand what kind of skills you may need to operate a bioreactor

### ***Academic Connections***

#### **ELA Literacy and/or Math Standard (if applicable, Science and/or Social Studies Standard):**

9-10.RI.1 Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text.

#### **Sample Performance Task Aligned to the Academic Standard(s):**

Read FDA and EPA regulations to become aware of guidelines

Read articles related to socio-economic and environmental impact in utilizing the bio-processed products

## **INDICATOR #BE 4: Career exploration in bioprocess engineering**

**SUB-INDICATOR 4.1 (Webb Level: 3):** Explore the role of bioprocess engineering in an agriculture related area

**SUB-INDICATOR 4.2 (Webb Level: 2):** Understand the role of bioprocess engineering in food processing

**SUB-INDICATOR 4.3 (Webb Level: 2):** Understand how bioprocess engineering is critical to water and wastewater treatment technologies

**SUB-INDICATOR 4.4 (Webb Level: 2):** Understand how bioprocess engineering can improve the rural economy

#### **Knowledge (Factual):**

Multiple area of focus that exist in bioprocessing

#### **Understand (Conceptual):**

Bioprocessing can be applied to food, feed, wastewater etc, thus opens up the multiple job

#### **Skills (Application):**

Be able to explore the bioprocessing related career opportunities in multiple areas (food,

Opportunities for rural economy with bioprocessing	opportunities  Bioprocessing can be applied to produce multiple products utilizing agricultural wastes thus improving the rural economy	feed, wastewater, environmental, etc)  Be able to identify ways to improve rural economy by developing biobased economy
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### **Benchmarks**

*Students will be assessed on their ability to:*

- Explore different areas of bioprocessing
- Identify how different aspects of daily life gets affected by bioprocessing
- Explore opportunities to expand rural economy

### **Academic Connections**

#### **ELA Literacy and/or Math Standard (if applicable, Science and/or Social Studies Standard):**

9-10.W.6 Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to the other information and to display information flexibly and dynamically

#### **Sample Performance Task Aligned to the Academic Standard(s):**

Visit industries to learn more about the integrated uses of technologies to produce biobased products.

Read articles on how rural economy could be improved by establishing bioprocessing industries in the local farms.

### **INDICATOR #BE 5: Understand workplace ethics and professionalism in bioprocess engineering**

**SUB-INDICATOR 5.1 (Webb Level: 1 and 2):** Investigate and demonstrate understanding of professionalism and workplace ethics in the technological environment.

#### **Knowledge (Factual):**

Know the terminologies like plagiarism, copyright, intellectual property right, ethical issues

#### **Understand (Conceptual):**

Violations of workplace ethics could lead to significant damage

It is important to recognize the work environments and

#### **Skills (Application):**

Be able to understand and define copyright, intellectual right, plagiarism

Recognize the

	appropriate attire  It is important to understand the ethical issues such as Copyright, intellectual property right,	importance of workplace attire
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### **Benchmarks**

*Students will be assessed on their ability to:*

- Identify different work environments and recognize appropriate professional attire
- Demonstrate and understanding of professional ethics issues such as plagiarism, copyright and intellectual property laws
- Differentiate between possible ethical choices.
- Role play to model different possible outcomes
- Brainstorm potential responses to various workplace ethics violations

### **Academic Connections**

<b>ELA Literacy and/or Math Standard (if applicable, Science and/or Social Studies Standard):</b>  9-10.W.6 Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to the other information and to display information flexibly and dynamically.	<b>Sample Performance Task Aligned to the Academic Standard(s):</b> Read articles and rewrite in your own sentences to avoid plagiarism.
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### **INDICATOR #BE 6: Understand safety and health in bioprocessing engineering**

**SUB-INDICATOR 6.1 (Webb Level: 1 Recall):** Understand implications of health and public safety standards

<b>Knowledge (Factual):</b>  Importance of safety procedures in bioprocessing  Troubleshooting the safety equipment	<b>Understand (Conceptual):</b>  For proper operation of the equipment and processes involved in bioprocessing, understanding the safety protocol is very important	<b>Skills (Application):</b>  Be able to follow the safety protocol  Identifying the importance of having a proper planning to
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Proper planning to improve the safety of worker	It is important to have proper planning to assure the safety of the worker	assure the safe work environment
<b>Benchmarks</b> <i>Students will be assessed on their ability to:</i> <ul style="list-style-type: none"> <li>List the safety procedures and equipment used in various technology sectors</li> <li>Demonstrate and understand the importance and use of safety equipment</li> <li>Evaluate the effectiveness of safety tools available for a given task</li> <li>Analyze potential consequences to self and others of not following health and safety standards</li> <li>Design a plan to improve the safety of a bioprocessing work environment.</li> </ul>		
<b><i>Academic Connections</i></b>		
<b>ELA Literacy and/or Math Standard (if applicable, Science and/or Social Studies Standard):</b>  9-10.W.6 Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to the other information and to display information flexibly and dynamically	<b>Sample Performance Task Aligned to the Academic Standard(s):</b>  Read the currently existing safety protocol of Bioprocessing Company  Create your own improved version of safety protocol for Bioprocessing Company.	

### **Additional Resources**

Please list any resources (e.g., websites, teaching guides, etc.) that would help teachers as they plan to teach these new standards.